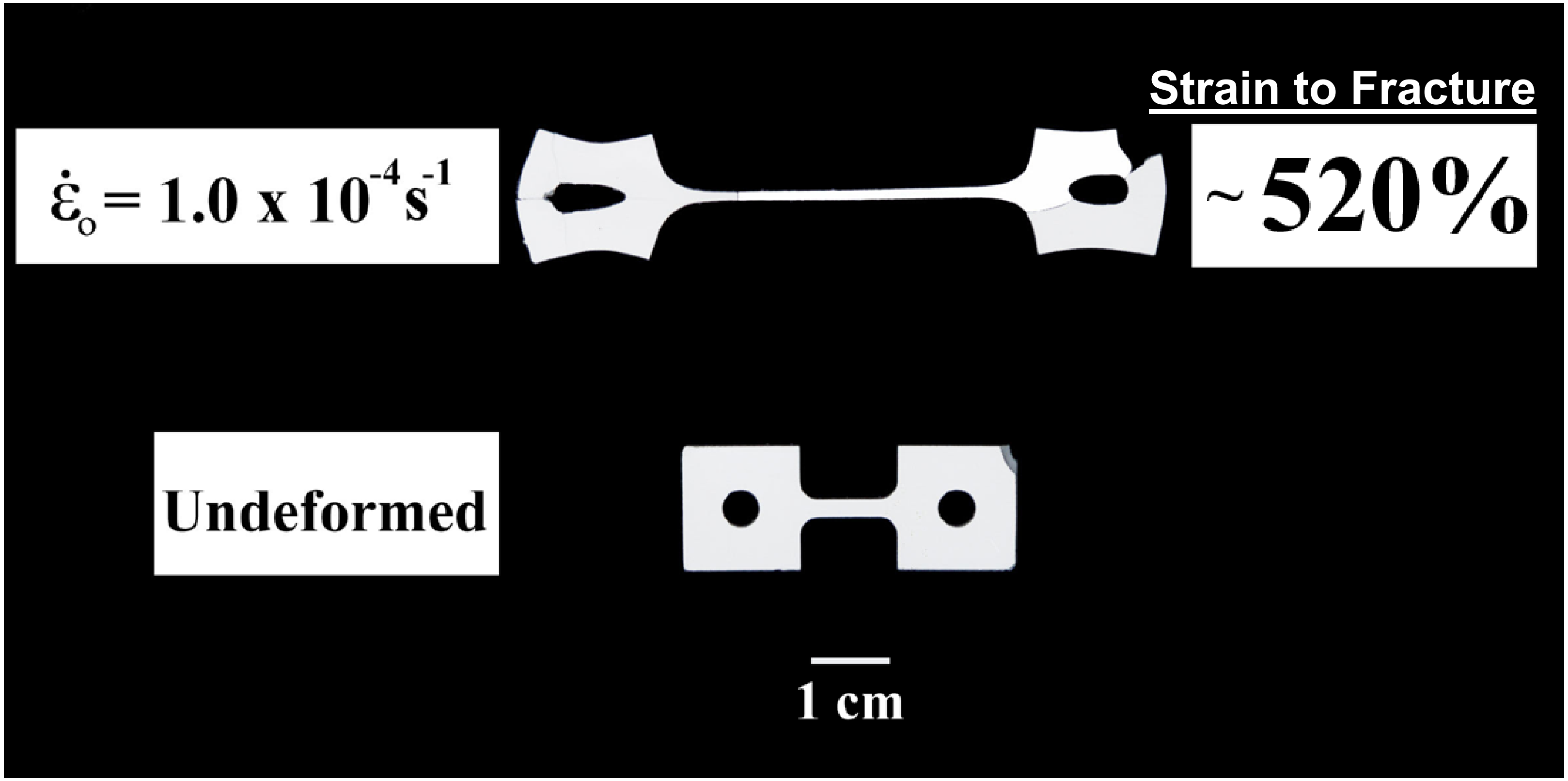
Superplastic Deformation of a Ceramic Material



8 mol% Y_2O_3 Cubic Stabilized ZrO_2 with 5 wt% SiO_2 Tested at 1425°C

Martha L. Mecartney, University of California, Irvine

Research sponsored by National Science Foundation under Grant No. DMR - 0207197

Superplastic Ceramic Materials

- Superplastic materials can withstand tensile deformations exceeding 100% elongation.
  - This property is often referred to as superplasticity.
- By dispersing a nanometer scale second phase in yttria stabilized cubic zirconia, this ceramic material was made superplastic.
  - The concept of using a dispersion of two nanoscale phases to enhance superplasticity in ceramics is currently being tested.
- Superplasticity enables superplastic forming (SPF).
  - Using SPF, complex shapes may be fabricated using significantly fewer steps than traditional manufacturing techniques and providing a more economical process.

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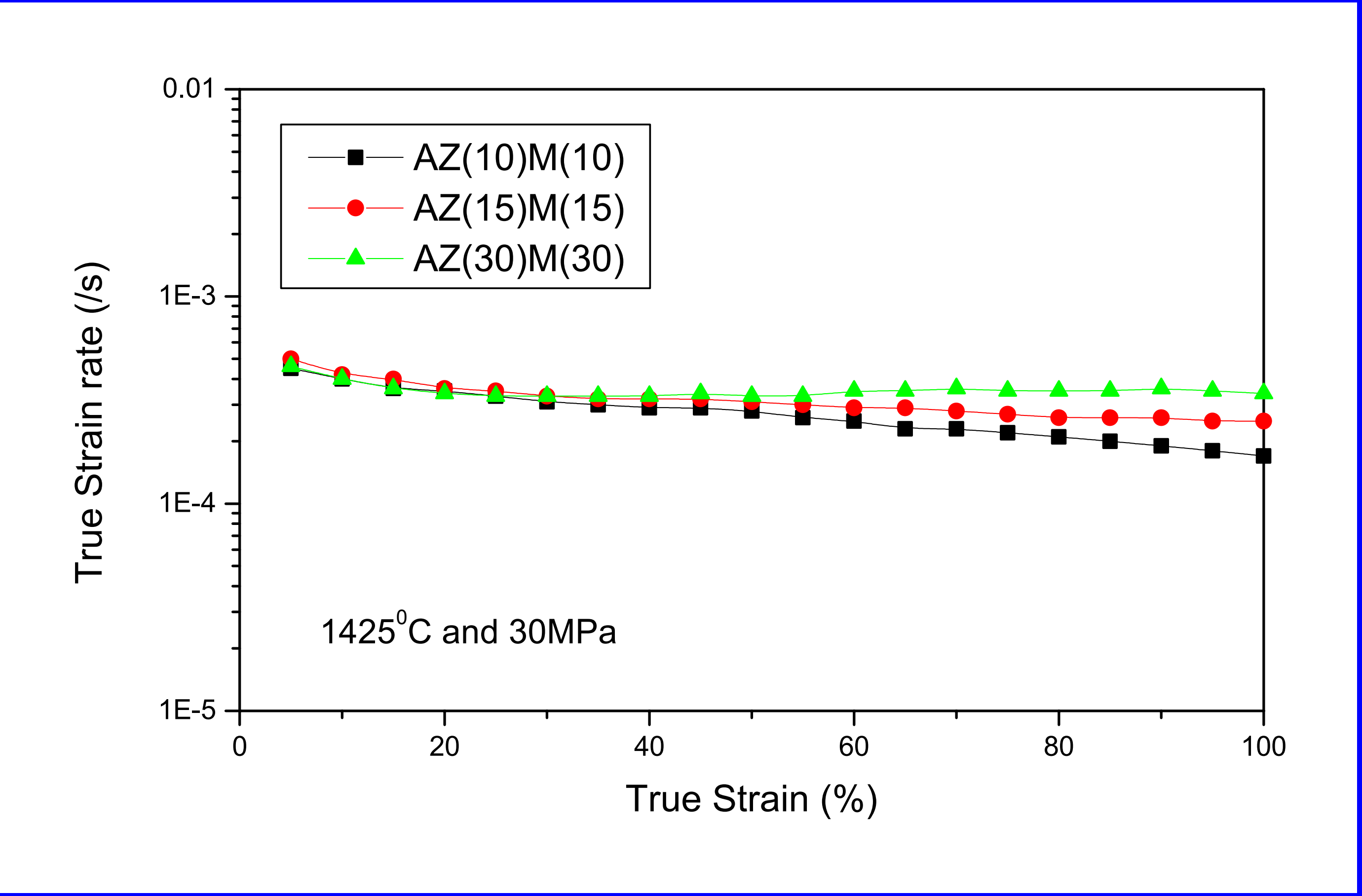
Superplastic Deformation of Alumina-based Composites (Alumina-Zirconia-Mullite)



The matrix is alumina and the volume percent of zirconia and mullite are indicted in parentheses in the key.

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Superplasticity in Alumina Composites

- One key requirement for ceramic superplasticity the retention of a fine grain (crystallite) size during deformation.
- This research investigates the possibility of using Al_2O_3 dispersed with ZrO_2 and mullite ($3Al_2O_3 \cdot 2SiO_2$) to make superplastic Al_2O_3.
- With an increase in the amount of the second and third phases, the strain rate becomes more stable, indicating that the tri-phase microstructure helps to limit grain growth.
- Several underrepresented undergraduate students were involved in the research effort and had an opportunity to participate in summer research during 2003. This research experience will help with future engineering employment and enhance their consideration of completing advanced degrees.

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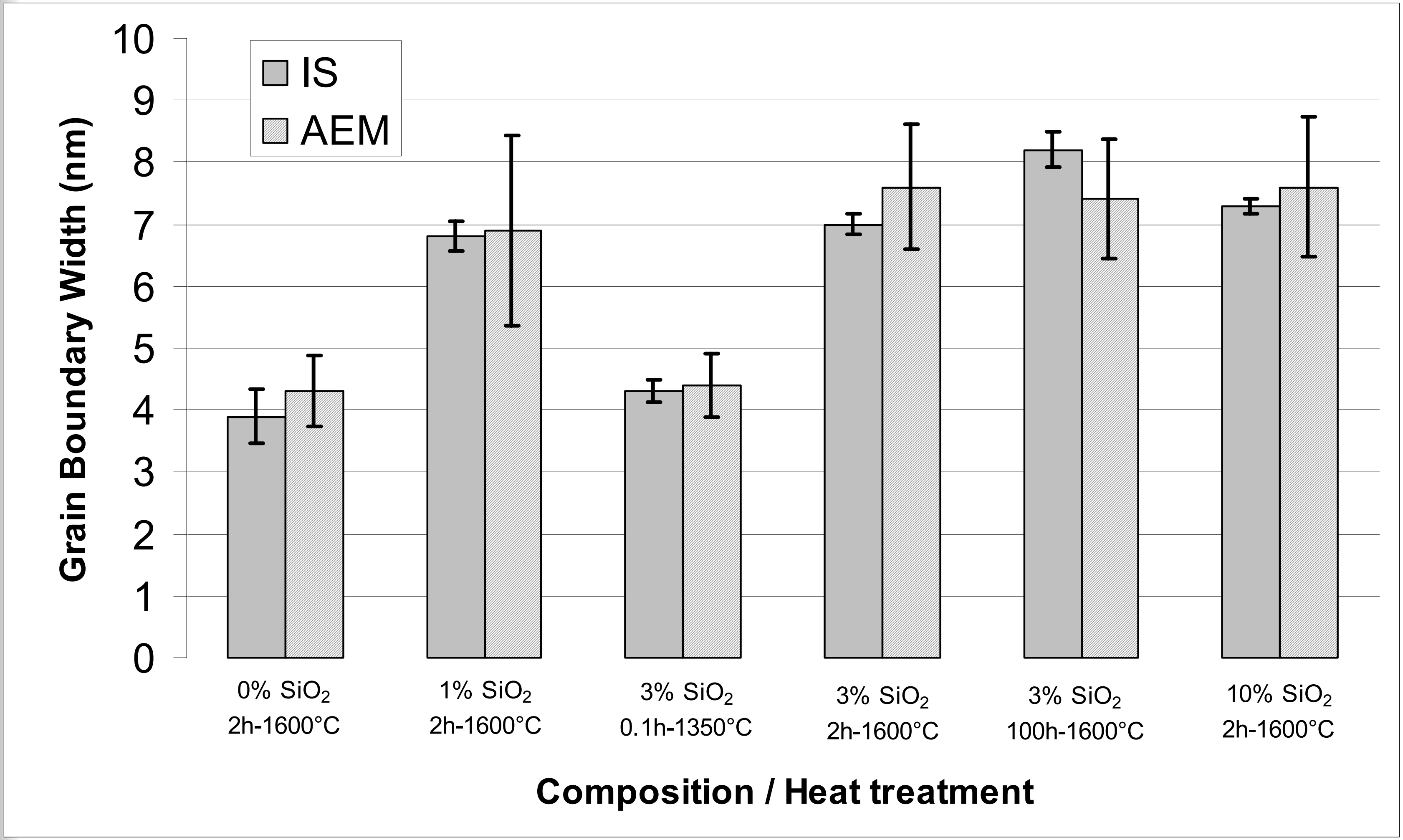
A Comparison of Grain Boundary Widths in Ceramics Determined by Impedance Spectroscopy (IS) and Analytical Electron Microscopy (AEM)



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A Comparison of Grain Boundary Widths in Ceramics Determined by Impedance Spectroscopy (IS) and Analytical Electron Microscopy (AEM)

- Segregation at grain boundaries can provide a chemical measure of the width of grain boundaries from compositional scans using analytical high resolution transmission electron microscopy (AEM).
- AEM is difficult, expensive and time consuming.
- An electrical grain boundary width can be determined using impedance spectroscopy (IS), if the grain size of the ceramic is known.
- IS is relatively easy and inexpensive.
- A comparison of the two techniques finds that IS data can be used to predict grain boundary widths, providing a new technique for quickly characterizing the average grain boundary width in a ceramic.

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